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AN EVALUATION OF A REGIONAL MASS MINIATURE RADIOGRAPHY PROGRAMME 1956–67

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AN EVALUATION OF A REGIONAL MASS MINIATURE RADIOGRAPHY PROGRAMME 1956–67

by
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A study of trends shown over eleven years by analysis of Christchurch-based units serving a population of half a million.

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Note: In the statistical tables, the symbol -- denotes an amount too small to be expressed

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SUMMARY AND CONCLUSIONS

Analysis of the findings of the two Christchurch mass miniature radiography units[1] for the years 1956, 1960 and 1967 has been undertaken. Trends in attendance, previous mass X-ray experience, recall rates, over-reading, total as well as specific abnormalities detected, have been examined and compared. Suggestions for the future economic role of mass X-ray units have been put forward.

The proportion of attenders at the units in each age and sex group has varied little over the years. The recent drive toward encouraging the older section of the community to participate has met with only limited success. Nearly half the attenders in 1967 were under the age of 35 years, that age group which today is likely to yield the least number of cases of either tuberculosis or lung cancer.

Although the position has been slowly improving over the years there is still a much greater proportion of women than men attending the units for the first time. This is attributed not so much to lack of opportunity for women to attend as to the easy opportunity being given to men in the conveniently accessible and male-dominated sections of industry and commerce. A much greater effort is needed to attract to the units both men and women of the older age group, particularly those over 60 years; even in 1967 some 20 percent of the attenders in this group had not had a previous X-ray.

Although the overall recall rate in 1956 was 1.3 percent, in 1960 and 1967 it stabilised at under 1 percent with a tendency towards an increasingly greater proportion of recalls amongst the older age groups. No difference was found in recall rates between the sexes in any age group. A difference was detectable in the recall rate between those who had had a previous X-ray and those who had not, and this difference is shown to be due to the availability of previous films for comparison.

No difference was found in the overall over-reading rates between 1960 and 1967 but a serious proportion of over-reading occurred in the youngest age group where nearly half those aged 15-24 years who were recalled in 1967 were subsequently found to be normal. This may have been due to a change of policy which by 1967 made comparisons of current with previous films impracticable. Over-reading was also a problem, but a less serious one, amongst the oldest age group. Over-reading of X-rays of women was commoner than over-reading of men's X-rays; the reason is probably the greater number of buttons and shadows in women's clothing.

Total abnormalities rose with age in each of the three years reviewed but the proportion of abnormalities has fallen over the years. This is largely accounted for by film readers having gradually accepted as being within normal limits conditions previously coded as abnormal. There is no evidence that patients found to have abnormalities were reluctant to attend again for a further film in subsequent years. The rate of abnormalities in single women did not differ from the rate in married women. The total abnormality rate was no higher in those not previously X-rayed than in those who had attended the unit before. The higher abnormality rate amongst certain occupational groups has been shown to be mainly due to the age distribution of the group rather than being an occupational effect, with the possible exception of public hospital employees. It is tentatively suggested that hospitals may selectively employ the less fit workers.

Specific abnormalities found suggested an increased incidence of thyroid enlargement and this may be worth further investigation. The discovery rate of primary carcinoma of the lung has increased over the years and by 1967 this was more commonly found than active tuberculosis. Hydatid disease, bronchiectasis and non-specific infections of the lungs appear to have decreased in frequency over the years. The rate of detected acquired heart disease appears to start

[1] For the sake of brevity, the terms "mass X-ray unit and "mass X-ray" have been used in this report for "mass miniature radiography unit" and "mass miniature radiography"

accelerating about ten years earlier in women than in men and it is suggested this should be further investigated. There is little evidence that the incidence of chronic bronchitis and emphysema has increased between 1960 and 1967 except possibly in the age group 55-64 years.

The fall in the rate of detection of tuberculosis parallels the decline in age-specific new notification rates over the years. As with the community incidence there has been little change in the tuberculosis case-finding rate amongst the older age groups. There is still a need for mass X-ray as a tuberculosis case-finding procedure for older men in particular. Four-fifths of the cases of lung cancer and tuberculosis discovered in 1967 had had previous, presumably normal, films.

It is advocated that the whole future of mass X-ray be reviewed. The emphasis should change from routine annual or biennial X-rays, from unprofitable X-raying of younger age groups towards twice-yearly, or even more frequent, X-raying of the older age groups. If mass X-ray were only available to those of 45 years of age and over little significant disease would be missed; most cases of active tuberculosis and lung cancer - as well as many other significant chest and heart diseases detectable by this means - would be discovered. The possible advantages of taking two X-rays, a PA and a lateral, of each patient with a view to increasing detection of carcinoma should be explored. The addition of further simple and unsophisticated respiratory and cardiological screening procedures (Total Chest Screening) for the older age group would almost certainly bring mass X-ray back to being an economic asset to community health - an asset which a continuation of the present policy is likely to jeopardize in the near future. Because public goodwill towards mass screening of this type is still very evident any limitation of the age groups examined may perhaps be best off-set by offering to the lower age groups some other screening procedure designed specifically to meet the needs of younger sections of the community as well as their general practitioners.

INTRODUCTION

In any field of preventive medicine it is important to stand back every now and then and take stock of what has been achieved. It is too easy to press on with a preventive measure which is acceptable to the public without challenging whether the economics and the usefulness have been adequately reviewed in the light of changing circumstances. The object of this study is to review from the first full year of operation the success and achievements of the mass X-ray units centred in Christchurch.

Although a fixed static 70 millimetre mass X-ray unit was stationed in Christchurch for some years prior to 1955 it was not until the middle of that year that a 45 millimetre mobile X-ray unit became available and full scale mass X-ray of the general public using both units was initiated. In 1956, in 1960, and again in 1967, accurate records were kept of every patient attending either of the two X-ray units and it is upon the results of these records that this present report has been compiled. The 1956 figures were hand sorted, but in 1960 and 1967 punch card analysis of the results was undertaken by the National Health Statistics Centre. The work involved in the basic coding was undertaken almost entirely by the staff of the District Health Office in Christchurch with some assistance in 1967 from the staff of the Dunedin District Health Office.

The original object of mass X-ray was to detect pulmonary tuberculosis. The fairly dramatic decline in the incidence of this disease over the past ten years raises the question of whether mass X-ray is any longer the best way of detecting this disease in the community. Moreover, with the rising incidence of lung cancer, considerable interest has been expressed as to whether mass radiography is useful in detecting this condition at a stage when it is still operable. The increasing interest taken by the public and medical profession in the incidence of heart disease raises the question of the extent to which mass X-ray units can contribute to the detection of this condition. There are other diseases too the incidence of which in the community could in theory be assessed by observation of the frequency of their detection on mass X-ray units.

However, there are serious difficulties to the extrapolation of figures obtained from mass X-ray units to the general public as a whole and it is generally conceded that it is unwise to assume that the incidence of a disease as shown by mass X-ray of the general public undertaken on a voluntary basis can be accepted as reflecting the incidence in the overall population (Cochrane, 1954; Heasman, 1961). There is some evidence to show that that segment of the population which comes forward readily for X-ray of their chest is a selected group with a creditable interest in the preservation of their own health (Joint Tuberculosis Council, 1964).

There is, however, so far as I am aware, no evidence to show that a group of people attending a mass X-ray unit in one year is likely to be selectively different from a group of people attending the same unit a few years later. It is upon this assumption that I have in this report taken the step of comparing the incidence of various diseases found during 1956, 1960 and 1967 as though they were coming from the same, albeit selected, population. Certainly a study of the itineraries of the Christchurch mass X-ray units when they were covering the population of the upper two-thirds of the South Island during 1956 and 1960 gives no a priori reason to conclude that there was likely to be much variation in the population offered the service.

In 1967, however, the matter was slightly different. When the planning stages for this investigation were being undertaken in 1966 with the medical officer of health of Christchurch it was intended that the geographic area covered by the two Christchurch units during the following year would be that which had been covered in the previous two surveys, so that all three years would be reasonably comparable. However, even the best laid plans go wrong and in 1967 a major and disastrous breakdown occurred in one of the Christchurch units and for a variety of frustrating and time-consuming technical reasons one of the units had to be "off the road" for nearly half the crucial survey year. This means that some reservations must be held as to whether the results obtained in the year 1967 are entirely comparable with those of the two previous survey years.

The total number X-rayed during 1967 was approximately two-thirds of the total number X-rayed in the other two years and while I have no reason to suppose that the missing one-third would invalidate comparisons - indeed the evidence presented here would suggest that it does not - nevertheless caution must be exercised in basing far-reaching conclusions upon these results.

METHOD

In a previously published document on the epidemiology of tuberculosis in Canterbury from 1946 to 1960 (de Hamel, 1962) details were given of the population structure of the main geographic area covered by the mass miniature radiography units centred on Christchurch. In addition to Canterbury, however, the units also served the Nelson-Greymouth Health District and part of the Timaru Health District, a total overall population of about 500,000 of whom some 350,000 were aged 15 and over at the 1966 census. In the latter area there are remarkably few Maoris (approximately 6,700) and although for 1956 and 1960 separate figures of abnormalities were taken out for the Maori population the extra work involved was not justified by the results achieved and racial differences could not be assessed. No effort was made in 1967 to take out separate figures for Maoris.

It was considered important to know whether the patient attending the mass miniature radiography unit had had a previous mass X-ray or not. If, as has been suggested (Fletcher et al, 1959; Springett, 1951) the greatest proportion of abnormalities is likely to be found in that group of the population which has not previously been X-rayed then it is essential to determine this with certainty so that any future propaganda towards mass X-ray can be directed towards that section of the population. In 1956 each patient was questioned about previous X-ray experience; only a very small proportion had had an X-ray before. The questions were again asked in 1960 and 1967 and some of the results reported here are based upon the replies received. Again a certain amount of caution should be exercised in interpreting the answers to the question of whether or not the patient has had a previous mass X-ray. It may be that as a result of the intensive propaganda and subsequent public goodwill and acceptance of the service that there is a bias towards admitting a previous X-ray when in fact none has been taken. Although records of all previous miniature X-rays taken by the Christchurch units were retained it would have been quite impracticable to have searched previous records to check the truth or otherwise of the statements made by each patient, particularly since patients are often vague as to how many years ago, or indeed where their previous X-ray was taken. The replies given by patients in 1960 and 1967 to the question about previous mass X-ray were therefore taken at face value and the results interpreted accordingly.

In 1960 previous miniature films were readily available for comparison purposes but by 1967 such a service was no longer available. The effect of this change of policy upon recall rate has been studied.

A very great deal has been published over the years on the question of observer error in relation to the reading of mass X-ray films. An intensive investigation was undertaken into this question in Christchurch in 1957 (de Hamel, 1959). At that time half the Christchurch miniature films were being read by a physician who was shown in that investigation to be an exceptionally able and most efficient miniature film reader from the point of view of minimum over-reading and under-reading as well as from the point of view of consistency. It was extremely fortunate therefore that the same physician was able to read half the films taken in 1956 and 1960 and all the films taken in 1967. The other half of the films taken in 1956 and 1960 was read by the author of this report and although his efficiency as a film reader is not equal to that of the main reader, nevertheless observer error is not likely to be a major source of error in the results presented here.

It had been originally hoped that detailed analysis by occupational groups would have been possible. This, however, was found to be impossible on the X-ray units partly because of the clerical difficulties associated with classifying a wide variety of occupations with the extreme rapidity required, and partly because of the problem of job mobility in this country. That an occupation was held in 1956 is certainly no guarantee that the same job will be held in 1960 or 1967. However, there are certain occupational groups which should be separated from the bulk of attenders at mass miniature radiography units for certain specific reasons.

It has been shown repeatedly that the incidence of tuberculosis in mental hospital patients is likely to be considerably higher than in other sections of the community (Walters, 1960-67). This group must therefore be treated separately. There are, moreover, very considerable technical difficulties in X-raying mental hospital patients and the reliability of accurate interpretation is correspondingly reduced. In each of the three years covered by this report between 2000 and 2500 mental hospital patients and staff were X-rayed but the results obtained from this group have been entirely omitted from the analysis of each of the three years to avoid the errors which their inclusion might engender.

Apart from this exclusion, all patients were divided into one of five groups. The first and by far the largest is the group entitled "Industry, commerce and public service" - the group that might be called the ordinary worker. The second group is perhaps more sociological than occupational in that it includes all retired people, housewives and others living at home and as such not therefore coming into contact with the general public to the extent expected in the first group. The object of making this a separate group was to see whether mass X-ray policy should be directed more towards X-raying blocks of workers or towards ferreting out individuals who spend a large proportion of their day in their own houses. The third occupational group which was separated was that of university and college students and staff. It was felt that this group could hardly be fitted into the category of industry and commerce and could in any case be an interesting group in its own right. The fourth category into which the patients were divided was that of the uniformed services. To make this a separate group was largely a follow-on from the post-war discovery of a higher incidence of tuberculosis in this group than expected and follows recommendations (Medical Research Council, 1953) that this group should receive particular study. The fifth and final occupational group into which patients in this report have been classified is that of hospital staff and patients. In all three survey years the vast majority in this group were domestic and ancillary workers working in public hospitals in the area.

The routine X-raying of the medical and nursing staff of public hospitals is undertaken by the hospital boards and has never been a regular part of the function of the Christchurch mass units. Moreover it is not normally part of the function of these units to X-ray patients attending public hospitals. Some, included at the request of the medical superintendents, were placed in this category. It is not now possible to say exactly how many patients have been included each year in this group. This is unfortunate in view of subsequent findings. I am only too conscious that these occupational groupings are not satisfactory but once the original decision had been made - nearly fifteen years ago now - it became impossible to alter the grouping in the subsequent surveys if comparisons were to be made.

The ages of the patients have been put into ten-year age groups to minimize errors, accidental or intentional, by the patients. Surprisingly few patients refused to reveal their ages but it may be noticed that this has made a slight difference to the apparent totals X-rayed when comparison is made between one table based on age groups and another based on total numbers X-rayed.

It is necessary to ask the marital status of female patients on mass X-ray units (in case letters have to be sent to the patient) and the opportunity was taken to see if abnormality rates of married and single women differed.

Separate figures were also taken out for those cases which had been specifically referred to the units by general practitioners but the total number referred in this way dropped from 1 in 200 in 1956 to less than 1 in 2,000 by 1967, and in none of these referrals was either tuberculosis or lung cancer found. No further breakdown of this particular group has therefore been undertaken. It would appear that the system of mass X-ray procedure in this country differs from that in the United Kingdom where general practitioner referrals are a particularly fruitful source of community disease detection (Joint Tuberculosis Council, 1964; Hartley and Walters, 1968).

Inevitably on mass miniature radiography units there is a proportion of spoilt films. A few of these are due to technical errors in the actual taking of the film; the majority occur in subsequent processing. On most units throughout the world a figure of around 1 percent is probably acceptable. The spoilt film percentages respectively for the three years studied were 1.6 percent, 0.6 per cent and 0.8 per cent. The high figure for 1956 was due to the accidental dropping of one fully-loaded exposed cassette containing some 630 films, an accident which was subsequently found to have fogged the entire contents. Fortunately this was an industrial group and the majority were able to be recalled within a few hours. In every case of spoilt film patients are requested to return for a repeat miniature and the proportion who do so is high. It is unlikely therefore that any serious errors will occur in the results shown in this study because of spoilt film.

The method by which the abnormalities detailed in this report were coded requires some explanation. A miniature film considered normal by the film reader was uncoded. A film showing a minor insignificant abnormality upon which a presumptive diagnosis could be made on the miniature film alone was coded appropriately as a miniature film abnormality and no further action taken. Among the few conditions classifiable to this category were bifid ribs and healed fractures of ribs and clavicles when they were readily recognisable on the miniature film alone. More commonly a diagnosis code from a miniature film alone was made by comparison of the miniature film with a previous large film upon which a definite diagnosis had been made upon radiological or clinical grounds. In this group some significant abnormalities, such as healed primary tuberculosis, congenital or acquired heart disease, pneumoconiosis or pleural thickening as well as many insignificant abnormalities were able to be validly coded on the miniature film alone. As a general rule, however, all significant abnormalities detected or suspected on the miniature film led to subsequent recall of the patient for a full-size 14" x 17" film before any coding was attempted. A provisional large film abnormality code was made and in the case of all significant abnormalities follow-up enquiries were made of general practitioners or chest specialists three months after the large film was taken to obtain a final diagnosis. The three month period was chosen to allow time for sputum culture and other lengthy investigations. Following receipt of the final diagnosis the provisional large film code was amended as necessary and this final code was used for the results presented here. The significant abnormalities recorded here are therefore based upon clinical and/or radiological diagnoses made subsequent to the taking of a large film. Insignificant abnormalities may have been coded upon the miniature film alone. The term "insignificant" here has been used to denote abnormalities which do not require further clinical or radiological investigation nor require the patient to have further observation or treatment.

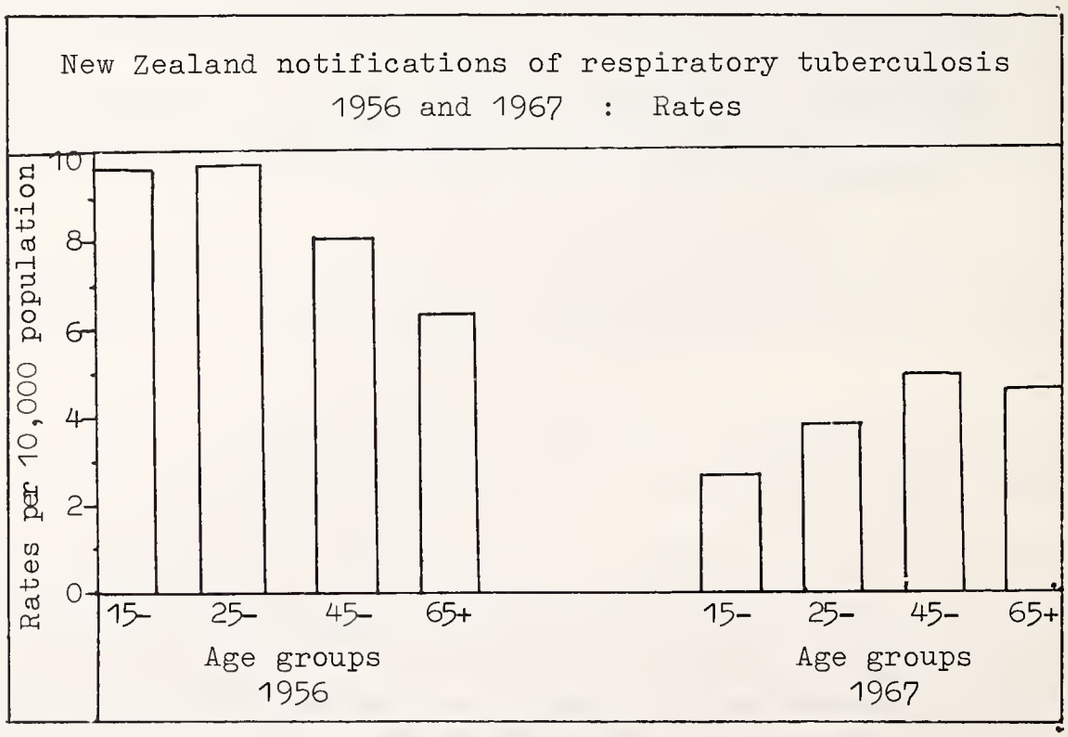
RESULTS

4.1 Mass miniature radiography attendance

Table 1 summarises by age and sex the attendance at the two Christchurch units for the three years, 1956, 1960 and 1967. Although over more recent years there has been fairly intense propaganda showing the need for the older group of the population, particularly men over 45, to come forward for mass X-ray the net result of this effort is not very great. There does appear to be a slight increase in the proportion of those over 45, both men and women, about 0.7 percent per annum. Undoubtedly the education of the elderly section of the public is having some effect but this is still small and is more noticeable in the women than in the men (1.0 and 0.5 percent per annum respectively). The overall pattern of distribution can be seen in Figures 1 and 2.

In 1956 half the men and over half the women attending the mass X-ray units were between the ages of 15 and 34. This could hardly have been more satisfactory from the point of view of tuberculosis control at that time (and prior to it) since the peak new notification rate for pulmonary tuberculosis for both males and females in Canterbury was exactly in that particular age group. In 1956 therefore an intensive drive in the younger age group for attendance at mass X-ray units was very laudable.

However, by 1967 the pattern of new notification rates for pulmonary tuberculosis had changed dramatically as is shown in the following diagram. No longer was the greatest rate of new notifications in the younger half of the community but in the older age group, centred around 55-64, particularly in males. The decrease in new notification rates in this older age group over the decade was very small compared with that in the younger age group.



If by 1967 the object of mass X-ray was to detect tuberculosis then the wrong age group attended. In a system of voluntary attendance the choosing of the age group which will attend is, of course, largely in the hands of the general public. This raises a very difficult question and one which will have to be resolved in the near future. To cut down on the proportion of young people attending mass X-ray units by means either of arbitrarily fixing a minimum age, say, of 40, or by active propaganda designed to discourage young people attending could have unfortunate consequences. Such a policy would almost certainly enormously increase the apparent discovery rate of both tuberculosis and lung cancer. However, active discouragement of the younger section of the population in a mass screening campaign might result in actual discouragement to the older, more profitable, sections of the community and would negate the educational value which we have placed in the past upon the importance of chest health in young people. This point is, of course, only relevant when considering the original object of mass X-ray, namely, to detect pulmonary tuberculosis. If other diseases are to be sought, or if additional screening procedures particularly relevant to the younger section of the population were to be added to current mass radiography units, then it could well be that the present age distribution of attenders at the screening units will be found to be satisfactory.

Table 2 shows the proportions by sexes and age groups of those who attended for the first time at a mass X-ray unit in 1960 and 1967. As has already been stated the vast majority of those who attended in 1956 were attending for the first time. This table shows a considerable difference between the sexes in respect of first attendance. In 1960 a much greater proportion of women in all age groups were apparently attending for the first time compared with their male counterparts. Broadly, the same was true in 1967 although the difference was not then so marked.

The most logical explanation for this sex difference might perhaps have been found in the greater attention paid by the units to industrial and commercial premises largely staffed by men; women who attended came largely of their own volition from the domestic scene. However, if this were so one would have expected that by 1967 the proportion of female first attenders would have caught up with the proportion of male first attenders if the opportunities offered to the two sexes had been equal. If the question of feminine diffidence towards coming forward for an X-ray can be over-ruled then one must assume either that insufficient opportunity has been offered to the women or alternatively, and more probably, too great and too frequent an opportunity has been offered to the men by repeated visits to the essentially masculine industrial and commercial strongholds.

If one excludes the age group 15 to 24, which naturally contains a higher proportion of first attenders than any other age group, then 11 percent of all males and 16 percent of all females in 1967 were first attenders compared with 23 percent and 41 percent respectively for 1960. The situation therefore so far as women are concerned is improving in that the proportionate differences between the sexes appear to be lessening and this might be taken as evidence of more rational usage of the X-ray plants in the later years.

What is not known, of course, and it would be extremely interesting to find out, is how many times those who are not attending for the first time have been X-rayed previously. While it can be said that there is no risk, from the X-ray dosage point of view, from repeated annual mass X-rays nevertheless from the economic point of view, repeated annual chest films of a healthy population could degenerate into a pointless and wasteful ritual. However, there is little doubt from the present figures that an even greater effort is needed to attract to the units both men and women over the age of about 60 of whom some 20 percent or more have never had a previous X-ray. It is in this age group in particular that the highest rate of abnormalities is likely to be found and although many of these may

be irreversible the general practitioner should nevertheless be made aware of the abnormality.

4.2 Recalls for large films

The number of people recalled for large films is important not only from the economic point of view but also because of the distress and anxiety caused to the patient who is recalled. The recall rate will depend upon the incidence of disease in the population studied, upon the ability of the film reader, and also upon the technical quality of the films he is expected to read. The left-hand column in Table 3 shows the comparison between the recall rates in 1960 and 1967 by age groups. Unfortunately it is not now possible to abstract such detailed information for 1956. However, in that year the total recall rate was 13.4 per 1,000 X-rays taken compared with 8.8 and 9.8 respectively for 1960 and 1967. In the two years for which age group analysis is available there is a clear trend towards fewer recalls amongst the younger age groups and a higher proportion of recalls amongst the older age groups. This could be a reflection of the lowering incidence of tuberculosis amongst the younger age groups but it is more likely to be related to the increased attention which is now being paid towards the abnormalities in the older age groups. Comparison of the overall recall rates in 1960 and 1967 by sexes does not reveal any marked difference in recall rate between the sexes in any of the age groups.

Because it could be that the recall rate is also partly dependent upon whether or not the patient has had a previous X-ray which can be used for comparison purposes the overall recall rate has been broken down in Table 3 into those who have previously been X-rayed and those who have not had a previous mass X-ray. This shows that in 1960 (when previous films were readily available for comparison) the proportion recalled in all age groups was greater in those not previously X-rayed. However, this pattern does not appear to have been followed in 1967 (when previous films were not available for comparison purposes) and there was a particularly high recall rate in those over 64 who had been previously X-rayed. Even if one excludes this latter age group the respective overall recall rates in 1967 in those who have and who have not been previously X-rayed is 8.4 and 8.7 per 1,000 X-rays respectively, a difference which is not marked. The conclusion must therefore be reached that the recall rate in those for whom a previous miniature film is available for comparison is likely to be lower than in those upon whose films a decision must be made in the absence of a previous film. It is the availability of the previous film, not the mere fact that a previous film has been taken, which appears important in reducing the recall rate. There is probably little doubt that a good mass X-ray film reader would prefer to have an opportunity of comparing a previous miniature film with the present one before he makes a decision as to whether to recall the patient or not. If the figures presented in Table 3 can be taken as reasonably reliable then it certainly suggests that as well as being reassuring to the film reader, a comparison of films may be profitable in terms of saving recalls.

4.3 Under-reading and over-reading

One of the greatest fears of a mass X-ray film reader is that he is missing abnormalities which could perhaps have been detected by another reader or by himself upon another occasion. Reference has already been made above to the experimental work which was undertaken on this particular unit using the film readers used throughout the period encompassed by this report. This investigation did reveal that there was a very flatteringly low proportion of missed abnormalities which were considered to be clinically significant.

It is, of course, impossible to produce a deus ex machina who can act as the ultimate criterion against which to compare the ability of a film reader. In the investigation referred to the under-reading of each reader was assessed against the combined results of four individual readers. It is possible that a significant abnormality can be overlooked even by four readers reading independently but the likelihood of this happening is relatively remote. Because it has been shown that readers of miniature films improve upon their under-reading only during their initial training period and because there is no evidence from the many investigations (Griep, 1955) which have taken place into this subject that deterioration in the ability of film readers takes place with time, I can only presume that what was found to be true in 1956 and 1957 is unlikely to have altered significantly over the years. Perhaps I am guilty of wishful thinking. There is, however, no method by which comparisons of under-reading between the three years reviewed here may be made. Over-reading is relatively easy to assess.

Table 4 compares the proportion of recalls ultimately found to be normal between 1960 and 1967 by age groups. It can be seen that the overall proportion of over-reading is almost identical in the two years under review. There are, however, some differences in rate between the individual age groups over the two years. This applies particularly to the youngest and the oldest age groups. Reference to the overall recall rate in 1967 as shown in Table 3 suggests that the relatively high figure in the oldest age group shown in that table is partly accounted for by the excess of over-reading now shown in Table 4. It is, however, in the youngest age group that the most serious amount of over-reading is occurring. In 1967 nearly half of those aged 15 to 24 who were recalled were subsequently found to be normal. This again might be taken as evidence that the value of X-raying this younger age group from the point of view of disease detection has become considerably less as the years go by. The most likely explanations of this high rate of unnecessary recalls in young people in 1967 are the lack of previous films for comparison and the prevalence of low-density shadows caused by buttons and other ornaments worn by this group in particular.

Table 5 shows the recall rate and over-reading by occupational groups in the three years reviewed. As would be expected the highest large film recall rate is to be found in that occupational group containing the most elderly patients and roughly vice versa. There does not appear to be any very clear relationship between over-reading and large film recall rate when examined from the point of view of individual occupational groups. The overall pattern indicates that in 1956 when there was a higher large film recall rate there was also a higher proportion of over-reading. The differences, however, between 1960 and 1967 are negligible.

A closer examination of the occupational group figures for 1967 is shown in Table 6. It is apparent that in every occupational group the recall rate amongst men was higher than it was in women and certainly for the bulk of those X-rayed during 1967 the proportion of over-reading amongst women was higher than it was amongst men. As explained above it was unfortunate that the occupational groups had to be divided in the way they were because this has led to gross imbalance between the five groups. However, such evidence as there is suggests that the highest recall rates are likely to be found amongst men living at home and men working in hospitals and that in these two groups the chances of something abnormal being found upon their subsequent large films are greater than in the other occupational groups examined here.

4.4 Overall abnormalities

The key to the success or otherwise of mass radiography has always been assumed to be the ability to detect tuberculosis. However, with the declining rate of tuberculosis in the community the value of using mass miniature radiography for the detection of conditions other than tuberculosis must be studied. In this section the total abnormality rates

are examined; in the next section attention is focused on the specific abnormalities found. Table 7 and Figures 3 and 4 show the abnormality rates in each age group and sex group for the three years 1956, 1960 and 1967. Two important findings are shown. Firstly, that the proportion of abnormalities rises directly with age in each of the three years under review and this is true for both sexes; secondly, that the proportion of abnormalities discovered in each age group has fallen with time.

Although on the whole the abnormality rate for males is rather higher in all the years under review than it is in females the difference is not striking. While it is to be expected that abnormalities will rise with age it is perhaps more surprising that the proportion of total abnormalities should have fallen so steadily between 1956 and 1967. It seems at first sight impossible to believe that a film reader who codes an abnormality in 1956 would code a steadily smaller proportion of these abnormalities in 1960 and 1967, particularly since the lessening proportion is almost constant by age group, sex and year. If it is conceded that the film readers remain reasonably constant in their detection and coding of abnormalities then one can assume that the trends shown could reflect the true situation.

There could be two possible explanations of this change over the years. Firstly, that those people with abnormalities detected the first time tend to keep away from the mass X-ray units in subsequent years (which is highly unlikely because in most cases the patient remains totally unaware of his abnormality) or secondly, that the differences between the abnormality rates represent remediable conditions, i.e. ones which are temporary or which can be cured before the patient's subsequent visit to the mass X-ray unit. As will be shown later the actual proportion of abnormalities which represent curable conditions is relatively low and thus this explanation of the differences seems unlikely to be the answer. Moreover the explanation cannot be found in cohort analysis because of the relatively short review period. This question will be further examined in the next section in the light of the specific abnormality changes which have apparently occurred over the years under review.

In an endeavour to see whether there were any differences in total abnormality rates between married and single women the figures by age groups have been calculated for 1967 and are shown in Table 8. Inevitably there are too few single women over the age of 25 for an entirely reliable comparison to be made but what evidence there is does not suggest any marked difference between the two groups worth further exploration.

Table 9 is a comparison of the abnormality rates in 1967 between those who have and have not had an X-ray previously. There is surprisingly little difference in the abnormality rates whether the patient has had a previous mass X-ray or not. This is probably fairly strong evidence that there is no tendency for people with abnormalities to decline coming forward again for further X-ray, a point which has been mentioned above as possibly accounting for the falling total abnormality rates over the years under review.

Table 10 shows the abnormality rates by occupational groups in the three years 1956, 1960 and 1967. The differences between the groups appear to be very much more a reflection of the age group concerned rather than any particular occupational group with the exception of the hospital staff. Here the abnormality rate is high in both 1956 and 1967 and the likely explanation is probably not that hospital staff tend to get infections more easily due to their occupation but that the age structure of this particular group happens to be heavily weighted towards the upper end.

This can be seen from the breakdown shown in Table 11 into age and sex groups for 1967. More than 20 percent of the hospital staff group X-rayed that year were aged over 64 and the abnormality rate for both sexes combined in the 65-and-over age group is similar to that found in the group

who are living at home. It is, of course, possible that hospital boards tend toward employing that less fit group of the community who might otherwise find it difficult to obtain employment in the competitive industrial and commercial market. That there may be some justification for an increased emphasis towards X-raying hospital staff is further suggested by the fact that of all those in this group who were found to have abnormalities, 60 percent were having their first mass X-ray. This compares with 11 percent for the industrial and commercial group and 15 percent for those living at home. In the age group 65-and-over the equivalent figures for hospital staff are 81 percent and for the other two groups 8 percent and 15 percent respectively. Even in the age groups between 45 and 64 the proportion of hospital staff with abnormalities being X-rayed for the first time is between two and three times higher than in the group living at home and eight times higher than in the industrial and commercial group.

4.5 Specific abnormalities

Table 12 shows all abnormalities found in 1956, 1960 and 1967 calculated as rates per 10,000 people X-rayed in each year. A study of this table begins to reveal why it is that the total abnormality rate over the three years under review has been falling. It is not credible that the incidence of congenital bony abnormalities has in fact been falling at the rate shown. Clearly what has been happening is that film readers have been coming to accept that congenital bony abnormalities, such as bifid ribs and cervical ribs, are sufficiently common to be within normal limits and these conditions have been coded as abnormal less and less as the years go by. The differences in acquired bony abnormalities may also be partly accounted for by this factor, but the variations here are more likely to be subject to observer error.

It is tempting to believe that the fall in the rate of coded calcified lymph nodes in the neck is related to the fall in calcified primary tuberculosis, which itself would be related to the known falling incidence of tuberculosis in the community. However, it is again difficult to believe that over the 11 years covered by this review the actual amount of calcification present either in the neck or the lungs within the community at large should have lessened. We have, as yet, no clear evidence that resorption of calcification following primary tuberculosis takes place. Dr. W.J. Smith (P.C.) has observed that the definite recognition of calcified foci and nodes has in recent years become more difficult both in mass miniature radiography and hospital practice and suggests that this may be due to a change in type of film or processing leading to a lower contrast picture.

There appears to have been a slight increase in the rate of thyroid enlargement particularly in 1967 and this point may need some independent investigation. The rate of detected congenital heart disease shows some fluctuation as indeed do the figures for acquired heart disease. The apparently steadily increasing rate of detection of primary carcinoma of the lung is probably genuine, reflecting the rising incidence of the disease in the community, and by 1967 this has become more frequently detected than active tuberculosis in both men and women, although the rate is still extremely low. Hydatid cysts, which were never common, appear to have vanished altogether by 1967 although with the relatively small number X-rayed in that year it is difficult to be completely confident that the occasional case will not continue to arise for a good many years to come. Acute non-tuberculous infections of the lungs, such as lobar pneumonia, seem to have been declining and this is probably genuine and a reflection of the more widespread use of antibiotics. Bronchiectasis is another condition which appears to have fallen genuinely but the rates for chronic bronchitis and emphysema for 1956 appear to be spuriously high in both men and women. This is probably a reflection of the extreme difficulty of making a definite diagnosis of these conditions in 1956 in the absence of accepted criteria at that time.

A fuller breakdown of the more common non-tuberculous abnormalities by age and sex is shown in Table 13 and Figures 5 to 8. The rates for acquired heart disease appear to start accelerating one decade earlier in women than in men and then continue at a higher level thereafter. Whether this is true in the community at large is not known but this is a matter which ought to be investigated further because of its significance in preventive medicine. The figures for pleural thickening and calcification are interesting and one must presume that part of the declining incidence over the years is due to the lowering of non-specific infections. The figures may also imply that resolution of pleural thickening can possibly occur. It is, of course, likely that the lower rates for this condition found in all age groups in 1967 are in part due to under coding. However, this is unlikely to account for the whole picture.

Acute non-tuberculous infection shows little change with age until the age group 55 to 64 when, as would be expected on clinical grounds, the incidence considerably increases. It has already been mentioned that in 1956 there were considerable difficulties in establishing an adequate criterion for chronic bronchitis although radiological emphysema could be fairly well defined. It is this lack of adequate criteria which has probably given rise to spuriously excessive rates in that first review year. There is, however, little evidence that the rate of chronic bronchitis and emphysema has been increasing except possibly in the age group 55 to 64.

Figures 9, 10 and 11 show the pattern of detected cases of arrested tuberculosis, of tuberculosis requiring either supervision or treatment and of active tuberculosis over the years under review. Although the overall incidence of active and quiescent tuberculosis has fallen steadily (and this fall is quite dramatic in the younger age groups paralleling the community incidence) nevertheless there is relatively little fall in the older age groups. Table 14 shows all pulmonary tuberculous abnormalities by age and sex and again it can be seen that the incidence of both active and inactive tuberculosis requiring supervision has shown overall little change for the better in men in the oldest age group. The figures for arrested post-primary tuberculosis do appear to show a steady decline in incidence over the years.

Table 15 gives a summary of the number of cases of tuberculosis and lung cancer detected by the Christchurch units in 1960 and 1967 in relation to previous experience of mass X-ray. About half the cases of tuberculosis and lung cancer in 1960 had not been X-rayed before; by 1967 the figure had dropped to less than 1 in 5. This means that four-fifths of the cases of lung cancer and tuberculosis discovered by the unit had been already X-rayed at least once and presumably found to have been normal. This finding indicates that there is a need to change the emphasis away from annual or biennial X-rays, away from the younger age groups and towards twice-yearly, or even more frequent, X-rays of the older age groups if it is tuberculosis and lung cancer which are considered to be the most important reasons for continuing the operation of mass radiography in its present form.

An analysis was made of selected abnormalities in relation to occupational groups for the year 1967. The highest rate of healed primary and post-primary tuberculosis occurred amongst hospital staff which tends to confirm the view that ex-tuberculous patients who might have difficulty in obtaining employment in industry and commerce are frequently employed by hospital boards. It is possible that these patients prefer to work in hospitals out of gratitude or for a sense of security. Two cases in this group required supervision or treatment. However, the group containing the highest proportion requiring supervision by the chest physician was that of the housewives, retired people and those living at home. One in twelve hundred men examined in the industrial and commercial group had tuberculosis requiring supervision and only one in three thousand had active tuberculosis. Of the women in this group one in two thousand had tuberculosis requiring supervision but none had active tuberculosis requiring treatment.

It would seem then that it is rapidly becoming unnecessary to continue to X-ray those people in industry, commerce and the public service if tuberculosis case-finding is the sole object of the exercise. If the detection of lung cancer as well as heart disease and chronic obstructive lung disease is to be considered a reasonable addition to the function of the units then, by limiting those examined to the age of 45 and over, the vast majority of these conditions would be caught in the net. If the lower age limit for mass radiography were in the future to be 45 very little significant disease would be likely to be missed. A few cases of tuberculosis, of reticulosis and of sarcoidosis are about the only reasonably common significant diseases which would remain undetected.

Repetitive X-raying of large sections of the fit population, although it will not do any harm, will progressively in the future do less and less good. The time seems to have come when a complete rethinking of the future role of mass radiography is needed. As a mass screening process it has more than shown its worth in the past and moreover has shown that the public is willing to come forward voluntarily to undertake mass screening procedures. If the public or any section of it is to be denied mass X-ray then it seems only reasonable to offer a more suitable alternative screening procedure.

The total cost, including depreciation, of operating the two units in Christchurch in 1956 was approximately $27,000. By 1960 this had risen to $30,000. The cost in 1967 cannot be estimated because of the prolonged breakdown of one unit but it would appear likely that the normal full year's operation would have cost in the region of $40,000. This is a very expensive way of finding eight cases of active pulmonary tuberculosis. Perhaps it is not an expensive way of finding eleven cases of lung cancer - particularly if this condition is detected at a stage sufficiently early to permit surgery.

As lung cancer is becoming more common perhaps greater emphasis should today be placed upon the potential use of mass miniature radiography for the detection of early cases of this condition rather than of tuberculosis. The value of taking both P.A. as well as lateral views of the chest must be explored in this respect (Wegelius, 1967). Again, it could be that the greatest future for mass radiography lies in the concept of "Total Chest Screening" in which the X-ray photograph is but part of a more extensive yet unsophisticated set of respiratory and cardiological screening procedures. If the application of such procedures could be limited to those age, sex and occupational groups most at risk, the somewhat higher overall cost involved would pale into insignificance against the saving of life, the extension of good health and the promotion of well-being among that section of the community shown here to be most clearly in need today.

TABLE 1 : COMPARISON OF AGE DISTRIBUTION OF ALL MASS MINIATURE RADIOGRAPHY ATTENDERS IN 1956, 1960 and 1967, BY AGE AND SEX

Age group	MALES						FEMALES					
	1956		1960		1967		1956		1960		1967	
	Number X-rayed	Percentage of total	Number X-rayed	Percentage of total	Number X-rayed	Percentage of total	Number X-rayed	Percentage of total	Number X-rayed	Percentage of total	Number X-rayed	Percentage of total
15 - 24	9,677	25.2	8,376	21.5	7,199	26.3	9,668	34.8	7,619	32.2	4,722	28.6
25 - 34	9,482	24.7	9,205	23.6	5,379	19.7	6,155	22.2	4,808	20.3	3,026	18.3
35 - 44	8,206	21.4	8,805	22.6	5,520	20.2	5,681	20.5	4,712	19.9	3,230	19.6
45 - 54	6,480	16.9	6,998	18.0	4,732	17.3	3,532	12.7	3,496	14.8	2,775	16.8
55 - 64	3,157	8.2	3,801	9.8	3,106	11.4	1,799	6.5	1,792	7.6	1,661	10.1
65+	1,285	3.4	1,738	4.5	1,413	5.2	847	3.1	1,085	4.6	1,079	6.5
Not stated	49	0.1	29	0.1	6	--	69	0.2	154	0.7	9	0.1
Totals	38,336	100	38,952	100	27,355	100	27,751	100	23,666	100	16,502	100

TABLE 2 : COMPARISON OF FIRST MASS MINIATURE RADIOGRAPHY ATTENDANCE RATES IN 1960 AND 1967, BY AGE AND SEX

Age group	MALES				FEMALES			
	1960		1967		1960		1967	
	Number X-rayed	Percentage First attenders	Number X-rayed	Percentage First attenders	Number X-rayed	Percentage First attenders	Number X-rayed	Percentage First attenders
15 - 24	8,376	28.2	7,199	38.4	7,619	31.6	4,722	47.0
25 - 34	9,205	22.8	5,379	13.0	4,808	39.1	3,026	16.9
35 - 44	8,805	19.5	5,520	8.9	4,712	35.7	3,230	12.7
45 - 54	6,998	21.2	4,732	8.6	3,496	40.0	2,775	12.4
55 - 64	3,801	24.3	3,106	10.2	1,792	47.5	1,661	16.4
65+	1,738	48.0	1,413	21.5	1,085	63.1	1,079	30.1
Not stated	29	17.2	6	--	154	34.5	9	33.3
Totals	38,952	24.2	27,355	18.2	23,666	37.9	16,502	24.7

Note: In 1956 virtually all those X-rayed had never had a previous mass miniature radiograph

TABLE 3 : COMPARISON OF RECALL RATE PER 1,000 X-RAYS TAKEN IN 1960 AND 1967 BY AGE AND PREVIOUS X-RAY EXPERIENCE

Age group	Overall recall rate		Recall rate in those previously X-rayed		Recall rate in those not previously X-rayed	
	1960	1967	1960	1967	1960	1967
15 - 24	6.9	4.0	5.7	3.8	9.9	4.4
25 - 34	7.6	4.9	6.9	4.7	9.6	5.8
35 - 44	9.2	8.9	7.2	8.9	15.0	8.9
45 - 54	9.1	13.1	7.5	12.1	13.2	21.3
55 - 64	11.6	19.5	9.9	19.2	15.2	22.0
65+	17.0	29.3	9.2	34.9	23.7	12.7
Totals	8.8	9.8	7.1	10.3	12.9	8.2

TABLE 4 : COMPARISON OF PROPORTION OF RECALLS FOUND TO BE NORMAL BETWEEN 1960 AND 1967, BY AGE GROUPS

Age group	1960		1967	
	Number of large films taken	Percentage normal	Number of large films taken	Percentage normal
15 - 24	111	35.1	48	45.8
25 - 34	107	17.8	41	14.6
35 - 44	124	15.3	78	16.7
45 - 54	95	16.8	98	20.4
55 - 64	65	7.7	93	7.5
65+	48	-	73	12.3
Totals	550	17.8	431	17.9

Note: The total number of large films taken in 1956 was 886 with 23.4 per cent normal (age breakdown not available)

TABLE 5 : COMPARISON OF RECALL RATE AND OVER-READING BY OCCUPATIONAL GROUPS, 1956, 1960 AND 1967

Occupational group	1956			1960			1967		
	Number X-rayed	Large film recall rate per cent	Percentage of recalls found to be normal	Number X-rayed	Large film recall rate per cent	Percentage of recalls found to be normal	Number X-rayed (1)	Large film recall rate per cent	Percentage of recalls found to be normal
Industry, commerce and public service	42,462	1.4	23.8	42,689	0.8	20.5	28,764	0.8	17.7
Housewives, retired and others living at home	15,496	1.6	20.2	15,002	1.1	13.9	9,992	1.5	18.4
University and college students and staff	5,954	0.4	30.4	135	0.7	(100.0)	2,481	0.5	25.0
Armed services, police etc.	1,504	0.9	38.5	4,792	1.0	10.9	740	0.4	--
Hospital staff and patients (excluding mental hospitals)	671	1.3	44.4	not available			1,872	1.8	11.8
Totals	66,087	1.3	23.4	62,618	0.9	17.9	43,849	0.9	17.6

Note: (1) Does not include 8 cases for whom occupation was not stated

TABLE 6 : RECALLS BY OCCUPATION AND SEX, 1967

Occupational group	Number X-rayed (1)		Number recalled		Recall rate per cent			Percentage of recalls found to be normal		
	Male	Female	Male	Female	Male	Female		Male	Female	
Industry, commerce and public service	22,637	6,127	203	34	0.9	0.6	0.8	16.7	23.5	17.7
Housewives, retired and others living at home	1,201	8,791	42	105	3.5	1.2	1.5	11.9	21.0	18.4
University and college students and staff	1,878	603	10	2	0.5	0.3	0.5	20.0	(50.0)	25.0
Armed services, police etc.	709	31	3	-	0.4	-	0.4	-	-	-
Hospital staff and patients (excluding mental hospitals)	924	948	23	11	2.5	1.2	1.8	13.0	9.1	11.8

Note: (1) Does not include 8 cases for whom occupation was not stated

TABLE 7 : COMPARISON OF ABNORMALITY RATE IN 1956, 1960 AND 1967, BY AGE AND SEX

Age group	MALES					
	1956		1960		1967	
	Number X-rayed	Percentage abnormal in each age group	Number X-rayed	Percentage abnormal in each age group	Number X-rayed	Percentage abnormal in each age group
15 - 24	9,677	2.4	8,376	1.7	7,199	0.6
25 - 34	9,482	4.5	9,205	3.0	5,379	1.2
35 - 44	8,206	6.1	8,805	4.7	5,520	2.6
45 - 54	6,480	9.0	6,998	7.0	4,732	4.0
55 - 64	3,157	14.4	3,801	10.1	3,106	7.0
65+	1,285	22.5	1,738	15.6	1,413	8.6
Not stated	49	-	29	6.9	6	(50.0)
Totals	38,336	6.5	38,952	5.1	27,355	2.9

Age group	FEMALES					
	1956		1960		1967	
	Number X-rayed	Percentage abnormal in each age group	Number X-rayed	Percentage abnormal in each age group	Number X-rayed	Percentage abnormal in each age group
15 - 24	9,668	1.9	7,619	1.2	4,722	0.5
25 - 34	6,155	3.4	4,808	2.2	3,026	1.3
35 - 44	5,681	5.0	4,712	3.4	3,230	2.0
45 - 54	3,532	7.1	3,496	5.3	2,775	3.3
55 - 64	1,799	12.7	1,792	8.8	1,661	4.5
65+	847	19.0	1,085	15.2	1,079	8.6
Not stated	69	-	154	7.1	9	(11.1)
Totals	27,751	4.8	23,666	3.7	16,502	2.3

Note: Parentheses indicate a percentage based on less than five abnormal cases

TABLE 8 : DISTRIBUTION OF FEMALE ABNORMALITIES BY AGE AND MARITAL STATUS, 1967

Age group	MARRIED WOMEN			SINGLE WOMEN		
	Total number X-rayed	Number of abnormalities	Percentage abnormal in each age group	Total number X-rayed	Number of abnormalities	Percentage abnormal in each age group
15 - 24	1,083	5	0.5	3,639	17	0.5
25 - 34	2,713	36	1.3	313	2	0.6
35 - 44	2,976	58	1.9	254	7	2.8
45 - 54	2,545	80	3.1	230	11	4.8
55 - 64	1,463	64	4.4	198	10	5.1
65+	925	79	8.5	154	14	9.1
Not stated	6	1	(16.7)	3	-	-
Totals	11,711	323	2.8	4,791	61	1.3

Note: Parentheses indicate a percentage based on less than five abnormal cases

TABLE 9 : ABNORMALITY BY AGE, SEX AND PREVIOUS MASS MINIATURE RADIOGRAPHY EXPERIENCE, 1967

Age group	MALES				FEMALES			
	Number previously X-rayed	Percentage abnormal in each age group	Number not previously X-rayed	Percentage abnormal in each age group	Number previously X-rayed	Percentage abnormal in each age group	Number not previously X-rayed	Percentage abnormal in each age group
15 - 24	4,431	0.6	2,768	0.6	2,504	0.4	2,218	0.5
25 - 34	4,681	1.2	698	1.4	2,516	1.2	510	1.6
35 - 44	5,031	2.6	489	2.9	2,819	2.1	411	1.7
45 - 54	4,324	4.0	408	4.4	2,431	3.0	344	4.9
55 - 64	2,788	6.9	318	8.5	1,389	4.5	272	4.0
65+	1,109	8.3	304	9.5	754	8.9	325	8.0
Not stated	6	(50.0)	-	-	6	(16.7)	3	-
Totals	22,370	3.0	4,985	2.3	12,419	2.4	4,083	2.0

BOTH SEXES

	Number previously X-rayed	Percentage abnormal in each age group	Number not previously X-rayed	Percentage abnormal in each age group
15 - 24	6,935	0.6	4,986	0.6
25 - 34	7,197	1.2	1,208	1.5
35 - 44	7,850	2.4	900	2.3
45 - 54	6,755	3.6	752	4.7
55 - 64	4,177	6.1	590	6.4
65+	1,863	8.5	629	8.7
Not stated	12	(33.3)	3	-
Totals	34,789	2.8	9,068	2.1

Note: Parentheses indicate a percentage based on less than five abnormal cases

TABLE 10 : ABNORMALITIES BY OCCUPATIONAL GROUPS, 1956, 1960 AND 1967

Occupational group	1956		1960		1967	
	Number X-rayed	Percentage abnormal	Number X-rayed	Percentage abnormal	Number X-rayed (2)	Percentage abnormal
Industry, commerce, public service, etc.	42,462	5.7	42,689	4.2	28,764	2.4
Housewives, retired and others living at home	15,496	7.2	15,002	5.9	9,992	3.7
University and college students and staff	5,954	2.3	135	2.2	2,481	0.5
Armed services, police, etc.	1,504	4.7	4,792	3.7	740	1.9
Hospital staff and patients(1)	671	6.0	not available		1,872	5.2
Totals	66,087	5.8	62,618	4.5	43,849	2.7

Notes: (1) Mental hospital patients and staff are excluded

(2) Does not include 8 cases for whom occupation was not stated

TABLE 11 : ABNORMALITIES BY OCCUPATIONAL GROUPS, AGE AND SEX, 1967

Age group	Sex	Industry, commerce and public service		Housewives, retired and others living at home		University and college students and staff		Armed services, police, etc.		Hospital staff and patients (excluding mental hospitals)	
		Number X-rayed	Percentage abnormal	Number X-rayed	Percentage abnormal	Number X-rayed	Percentage abnormal	Number X-rayed	Percentage abnormal	Number X-rayed	Percentage abnormal
15 - 24	Male	4,974	0.6	16	-	1,788	0.6	342	0.9	79	(1.2)
	Female	3,398	0.5	613	0.5	579	(0.2)	19	-	113	-
25 - 34	Male	4,994	1.3	11	-	71	-	200	1.0	103	-
	Female	714	0.8	2,209	1.4	13	-	4	-	86	2.3
35 - 44	Male	5,248	2.6	13	(7.7)	14	-	76	(1.3)	169	3.6
	Female	874	0.5	2,180	2.6	5	-	3	-	168	2.4
45 - 54	Male	4,404	3.9	33	(3.0)	2	-	43	7.0	250	4.8
	Female	809	2.8	1,804	3.0	1	(100)	-	-	161	8.1
55 - 64	Male	2,603	6.9	295	6.8	2	-	29	6.9	177	9.0
	Female	297	5.1	1,193	4.4	3	-	1	-	167	3.6
65+	Male	414	4.8	833	9.7	1	-	19	10.5	146	12.3
	Female	35	14.3	786	8.7	2	-	4	(25.0)	252	7.5
Totals(1)	Male	22,637	2.7	1,201	8.6	1,878	0.5	709	1.8	924	5.7
	Female	6,127	1.2	8,785	3.0	603	0.3	31	3.2	947	4.6

Notes: (1) Does not include 8 cases for whom occupation was not stated, and 7 females for whom age was not stated.

(2) Parentheses indicate one abnormality only

TABLE 12 : ALL ABNORMALITIES FOUND 1956, 1960, 1967 - RATES PER 10,000 X-RAYED

Abnormality	MALES			FEMALES			TOTAL		
	1956	1960	1967	1956	1960	1967	1956	1960	1967
Congenital bony abnormality	53.8	13.6	2.2	64.2	12.7	1.2	58.1	13.3	1.8
Acquired bony abnormality	32.4	39.8	15.0	12.6	19.0	9.1	24.1	31.9	12.8
Primary and secondary tumours of bone	0.3	0.5	1.1	-	-	-	0.2	0.3	0.7
Calcified lymph nodes in neck	4.2	-	0.4	4.3	1.3	0.6	4.2	0.5	0.5
Thyroid enlargement	2.6	2.8	3.7	7.6	5.5	14.5	4.7	3.8	7.8
Oesophageal pouches and hiatal herniae	0.3	1.8	0.4	0.4	2.5	1.2	0.3	2.1	0.7
Congenital heart disease	2.3	4.1	2.2	3.2	4.2	1.2	2.7	4.2	1.8
Acquired heart disease	29.0	26.2	15.7	47.6	86.2	40.0	36.8	48.9	24.9
Pleural thickening or calcification	158.6	175.6	92.9	56.9	47.7	33.3	115.9	127.3	70.5
Non-tuberculous pleural effusion or emphysema	1.3	-	2.9	0.4	-	2.4	0.9	-	2.7
Eventration or paralysis of diaphragm	5.5	6.9	2.6	8.3	4.6	1.8	6.7	6.1	2.3
Primary carcinoma of lung	0.8	1.3	3.3	-	0.4	1.2	0.5	1.0	2.5
Secondary malignant deposits in lung	-	0.5	-	-	0.4	0.6	-	0.5	0.2
Benign tumours of lung	0.5	0.3	-	0.4	0.8	-	0.5	0.5	-
Acquired benign cysts of lung	0.3	0.5	-	-	0.4	-	0.2	0.5	-
Hydatid cysts	0.8	0.3	-	1.1	0.4	-	0.9	0.3	-
Fungus infections of lung	-	0.3	-	-	-	-	-	0.2	-
Congenital anomalies of lung	6.3	9.2	0.4	2.5	1.3	-	4.7	6.2	0.2
Acute non-tuberculous infection	14.4	10.5	8.0	5.8	6.8	3.0	10.7	9.1	6.2
Chronic bronchitis and emphysema	48.3	19.3	19.0	18.7	8.5	9.1	35.9	15.2	15.3
Bronchiectasis	7.0	5.1	0.7	5.0	2.5	1.8	6.2	4.2	1.1
Pneumoconiosis	1.6	3.6	0.4	-	-	-	0.9	2.2	0.2
Spontaneous pneumothorax	-	-	0.4	-	-	-	-	-	0.5
Mediastinal adenopathy (reticulosis)	1.3	-	0.4	1.4	0.4	0.6	1.4	0.2	0.5
Sarcoidosis	1.6	1.0	1.5	3.2	3.0	3.6	2.3	1.8	2.3
Calcified primary tuberculosis	141.4	84.7	57.4	112.0	68.8	54.0	129.1	78.7	56.1
Arrested post-primary tuberculosis	97.0	64.7	43.1	86.1	55.8	37.0	92.5	61.3	40.8
Inactive tuberculosis requiring supervision	18.5	9.0	8.0	13.7	11.8	8.5	16.5	10.1	8.2
Active tuberculosis requiring treatment	12.0	3.9	2.6	9.0	3.8	0.6	10.7	3.8	1.8
Miscellaneous abnormalities	6.8	21.1	3.7	11.5	20.3	6.7	8.8	20.8	4.8
Total number X-rayed	38,336	38,952	27,355	27,751	23,666	16,502	66,087	62,618	43,857

TABLE 13 : SELECTED NON-TUBERCULOUS ABNORMALITIES BY AGE AND SEX IN 1956, 1960 AND 1967
(Rates per 10,000 X-rays)

Abnormality	Sex	Age groups								
		15 - 24			25 - 34			35 - 44		
		1956	1960	1967	1956	1960	1967	1956	1960	1967
Acquired heart disease	Male	2.1	2.4	-	6.3	6.5	3.7	6.1	4.5	3.6
	Female	2.1	1.3	2.1	3.3	4.2	6.6	17.6	14.9	18.6
Pleural thickening or calcification	Male	47.6	35.8	18.1	112.8	95.7	31.6	158.4	177.1	88.8
	Female	17.6	10.5	8.5	58.5	35.4	13.2	73.9	50.9	21.7
Acute non-tuberculous infection	Male	19.6	6.0	4.2	7.4	10.9	9.3	12.2	3.4	5.4
	Female	7.2	2.6	-	4.9	6.2	-	10.6	12.7	3.1
Chronic bronchitis and emphysema	Male	4.1	6.0	4.2	9.5	4.3	5.6	34.1	12.5	12.7
	Female	-	2.6	2.1	1.6	2.1	-	7.0	8.5	9.3

Abnormality	Sex	Age groups								
		45 - 54			55 - 64			65+		
		1956	1960	1967	1956	1960	1967	1956	1960	1967
Acquired heart disease	Male	26.2	27.2	12.7	107.6	57.9	38.6	365.6	282.0	148.7
	Female	56.6	120.0	28.8	244.5	340.3	78.2	519.2	839.0	333.7
Pleural thickening or calcification	Male	251.5	248.6	164.8	361.0	392.0	225.4	373.4	500.6	184.0
	Female	84.9	80.1	88.5	127.8	100.4	60.2	118.1	156.6	55.6
Acute non-tuberculous infection	Male	7.7	10.0	6.3	25.3	26.3	16.1	47.7	34.5	21.2
	Female	5.7	5.7	7.2	16.7	-	12.0	-	27.6	-
Chronic bronchitis and emphysema	Male	61.7	27.1	14.8	171.0	47.4	67.6	389.0	103.6	77.9
	Female	28.3	20.0	14.4	83.4	16.7	30.1	177.0	27.6	18.6

TABLE 14 : TUBERCULOUS ABNORMALITIES BY AGE AND SEX IN 1956, 1960 AND 1967
(Rates per 10,000 X-rays)

Abnormality	Sex	Age groups								
		15 - 24			25 - 34			35 - 44		
		1956	1960	1967	1956	1960	1967	1956	1960	1967
Calcified primary tuberculosis	Male	70.3	19.1	12.5	122.3	63.0	24.2	169.4	96.5	59.8
	Female	60.0	22.3	14.8	113.7	52.0	33.1	140.7	76.4	55.7
Arrested post-primary tuberculosis	Male	4.1	4.8	5.6	46.4	44.5	11.2	106.1	60.2	45.3
	Female	6.2	2.6	4.2	32.5	33.3	19.8	117.9	70.0	43.3
Inactive tuberculosis requiring supervision	Male	6.2	2.4	-	27.4	9.8	1.9	12.2	7.9	10.9
	Female	5.2	10.5	-	16.3	18.7	3.3	14.1	12.7	6.2
Active tuberculosis requiring treatment	Male	6.2	2.4	2.8	14.8	2.2	1.9	9.8	5.7	3.6
	Female	7.2	2.6	-	14.6	6.2	-	7.0	6.4	-

Abnormality	Sex	Age groups								
		45 - 54			55 - 64			65+		
		1956	1960	1967	1956	1960	1967	1956	1960	1967
Calcified primary tuberculosis	Male	175.9	118.6	76.1	228.1	150.0	154.4	256.8	178.4	127.4
	Female	135.8	131.6	72.1	194.4	111.6	108.3	236.3	156.6	148.4
Arrested post-primary tuberculosis	Male	160.2	110.0	57.0	253.4	123.6	103.0	412.2	172.5	155.6
	Female	175.5	91.6	57.7	281.5	161.8	60.2	389.5	138.2	111.2
Inactive tuberculosis requiring supervision	Male	27.8	11.4	8.5	19.0	21.0	12.9	38.9	5.8	49.5
	Female	22.7	2.9	2.5	22.2	11.2	18.1	35.4	18.4	9.3
Active tuberculosis requiring treatment	Male	13.9	2.9	-	25.3	5.3	3.2	7.8	11.5	7.1
	Female	8.5	-	-	11.1	-	-	-	-	9.3

TABLE 15 : TUBERCULOSIS REQUIRING SUPERVISION OR TREATMENT AND PRIMARY LUNG CANCER IN RELATION TO PREVIOUS EXPERIENCE OF MASS X-RAY, 1960 AND 1967

Age group	1960				1967			
	TUBERCULOSIS		LUNG CANCER		TUBERCULOSIS		LUNG CANCER	
	Number detected	Number not X-rayed before	Number detected	Number not X-rayed before	Number detected	Number not X-rayed before	Number detected	Number not X-rayed before
15 - 24	14	6	-	-	2	1	-	-
25 - 34	23	14	-	-	3	-	-	-
35 - 44	21	11	1	-	10	2	1	-
45 - 54	11	3	1	-	11	3	3	1
55 - 64	12	2	2	1	8	2	4	1
65+	5	4	2	2	10	-	3	-
Totals	86	40	6	3	44	8	11	2
Percentage not X-rayed before		46.5		50.0		18.2		18.2
Of all X-rays taken percentage not previously X-rayed		29.3				20.7		

Figure 1

Proportionate attendance by age groups
1956, 1960 and 1967
Males

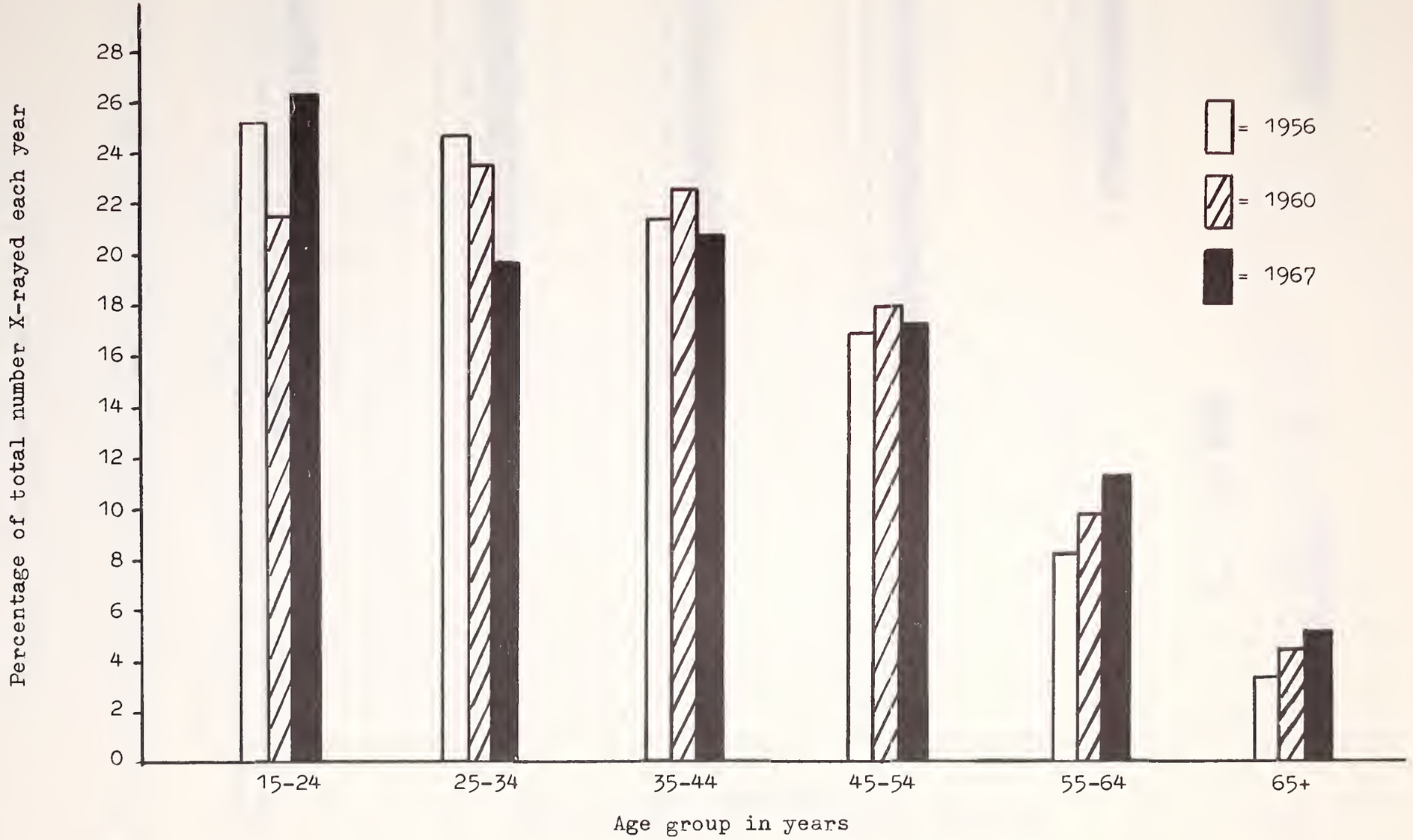
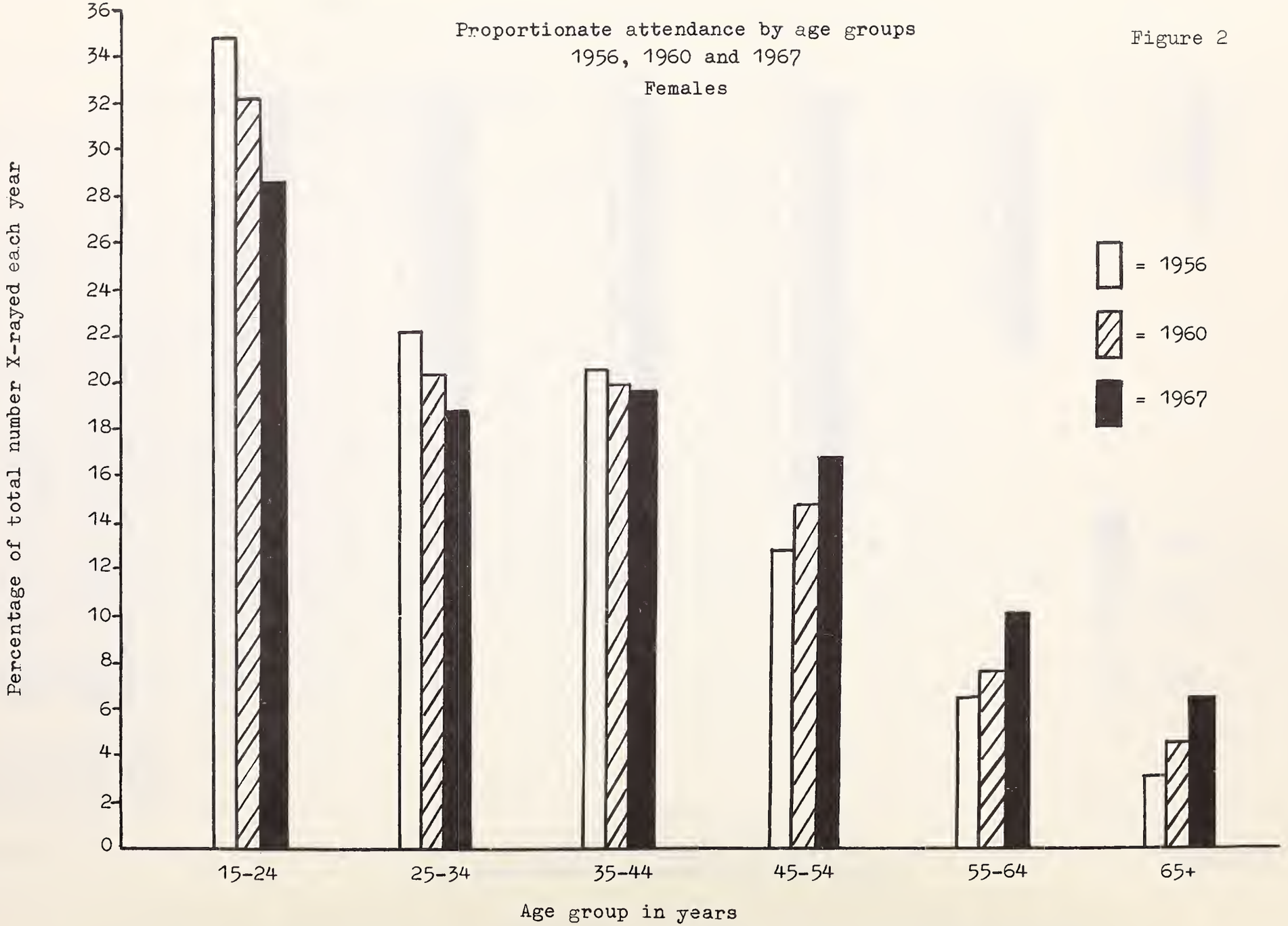


Figure 2

Proportionate attendance by age groups
1956, 1960 and 1967
Females



Proportion of abnormalities in each age group
1956, 1960 and 1967
Males

Figure 3

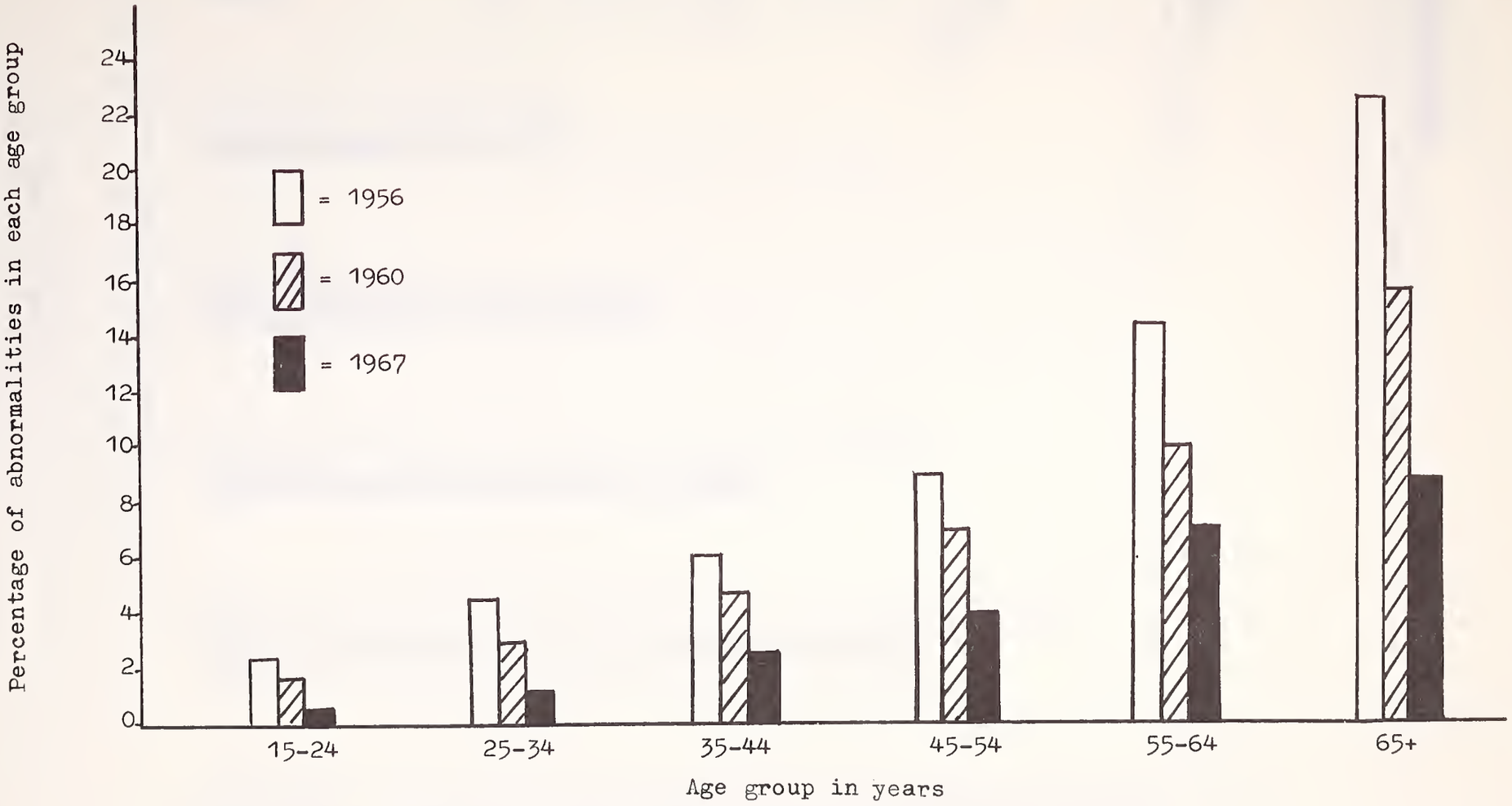
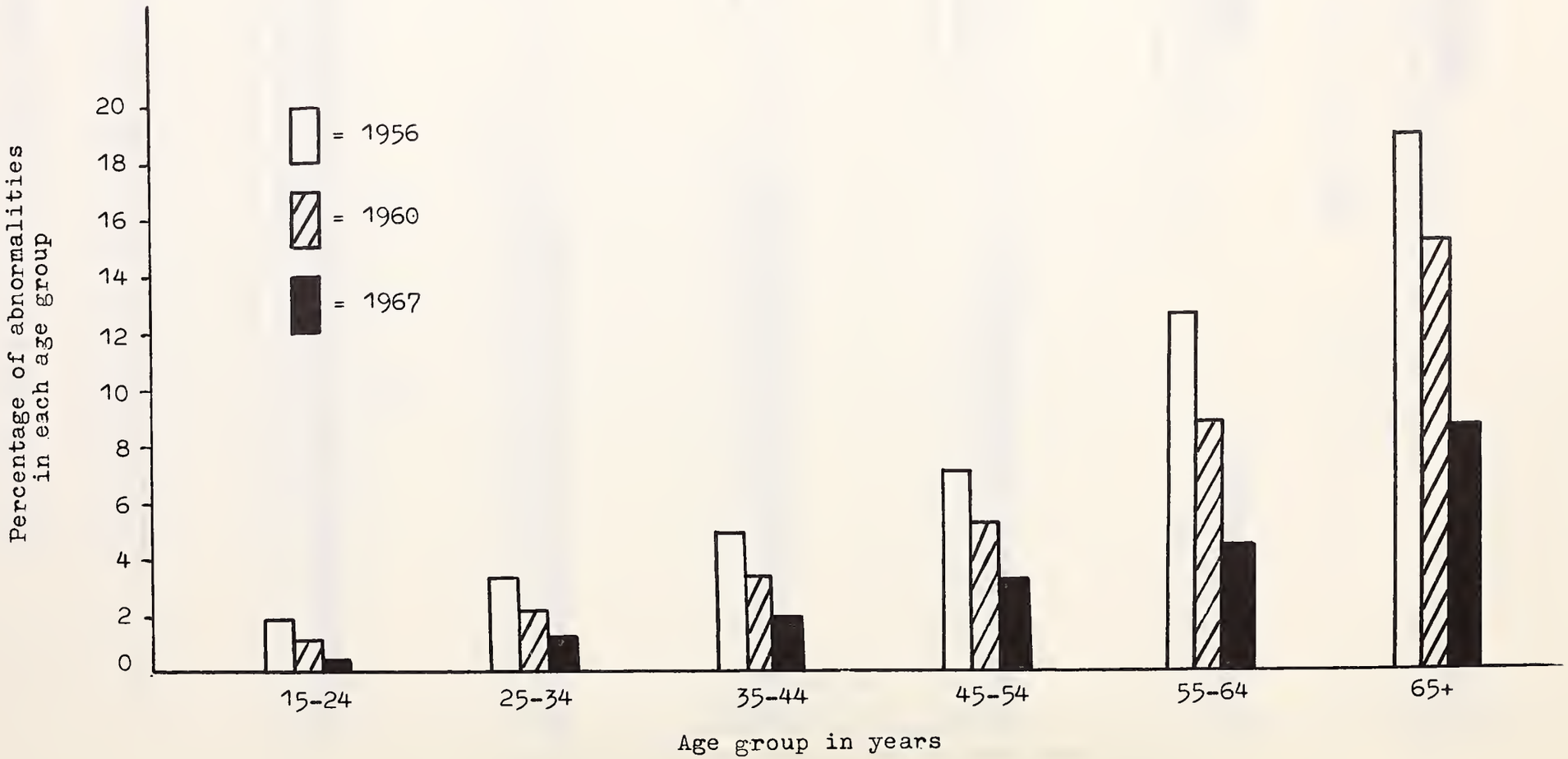


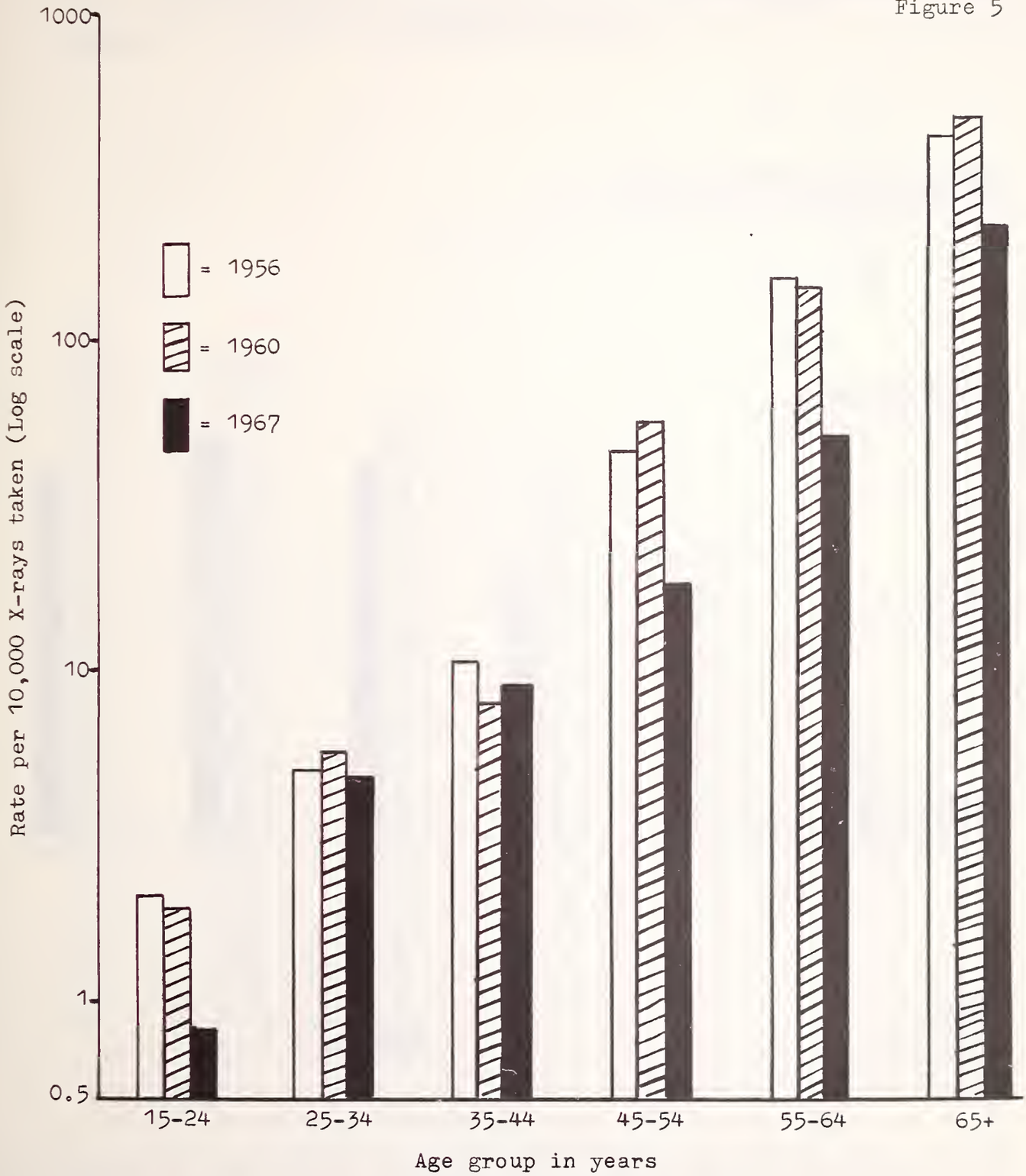
Figure 4

Proportion of abnormalities in each age group
1956, 1960 and 1967
Females



Acquired heart disease

Figure 5



Pleural thickening

Figure 6

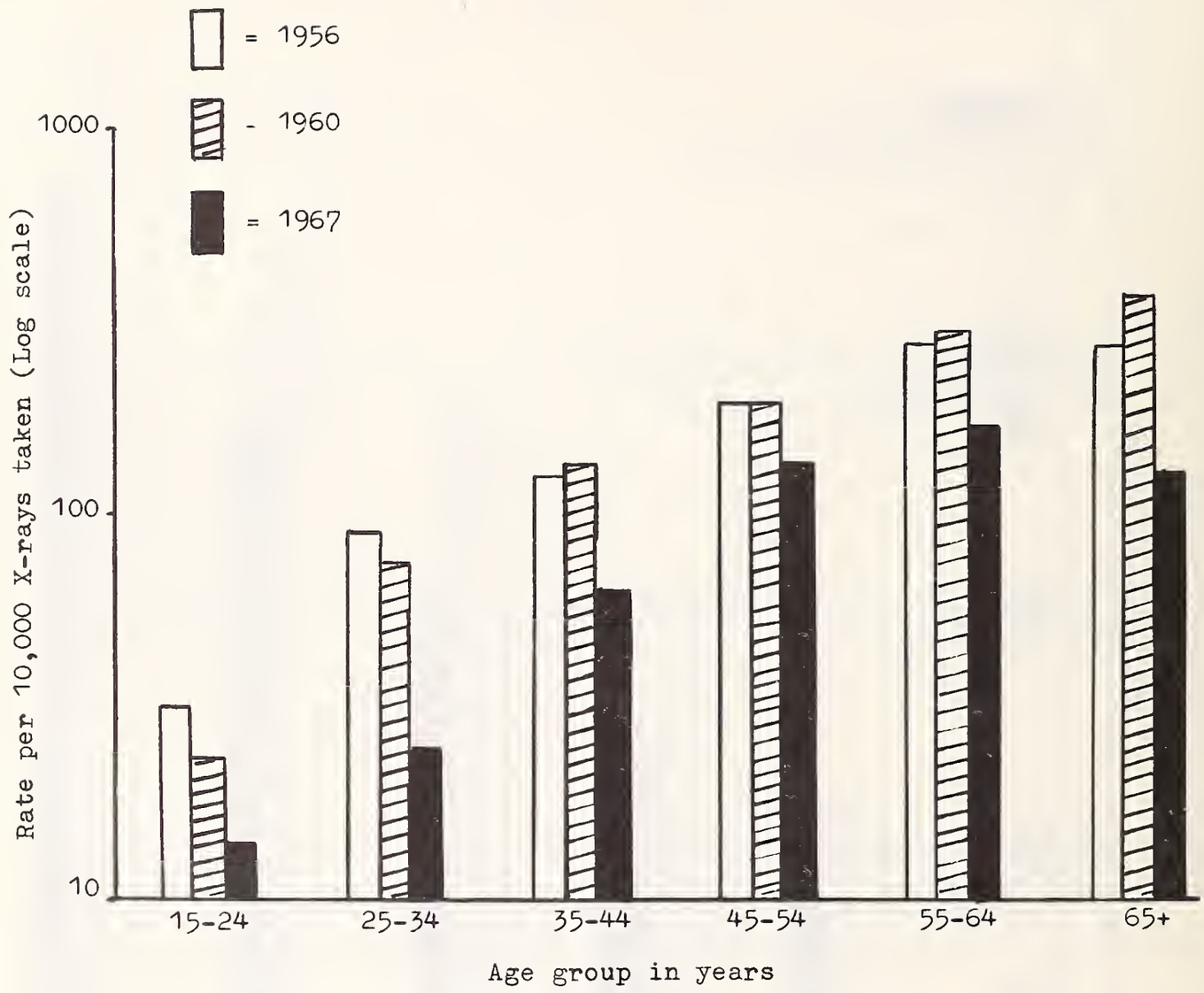


Figure 7

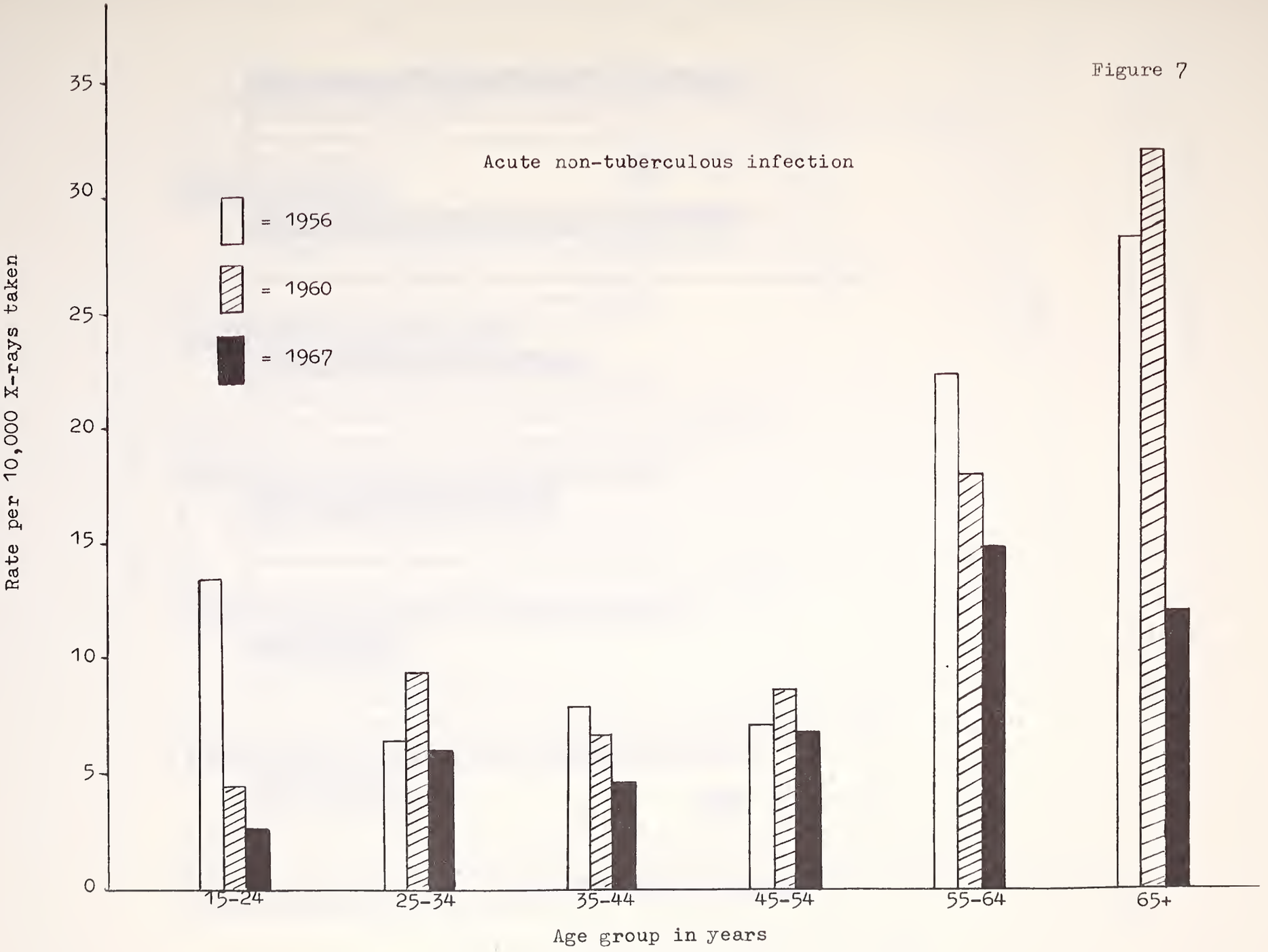

Acute non-tuberculous infection
= 1956
= 1960
= 1967
Rate per 10,000 X-rays taken
0
5
10
15
20
25
30
35
15-24
25-34
35-44
45-54
55-64
65+
Age group in years

Figure 8

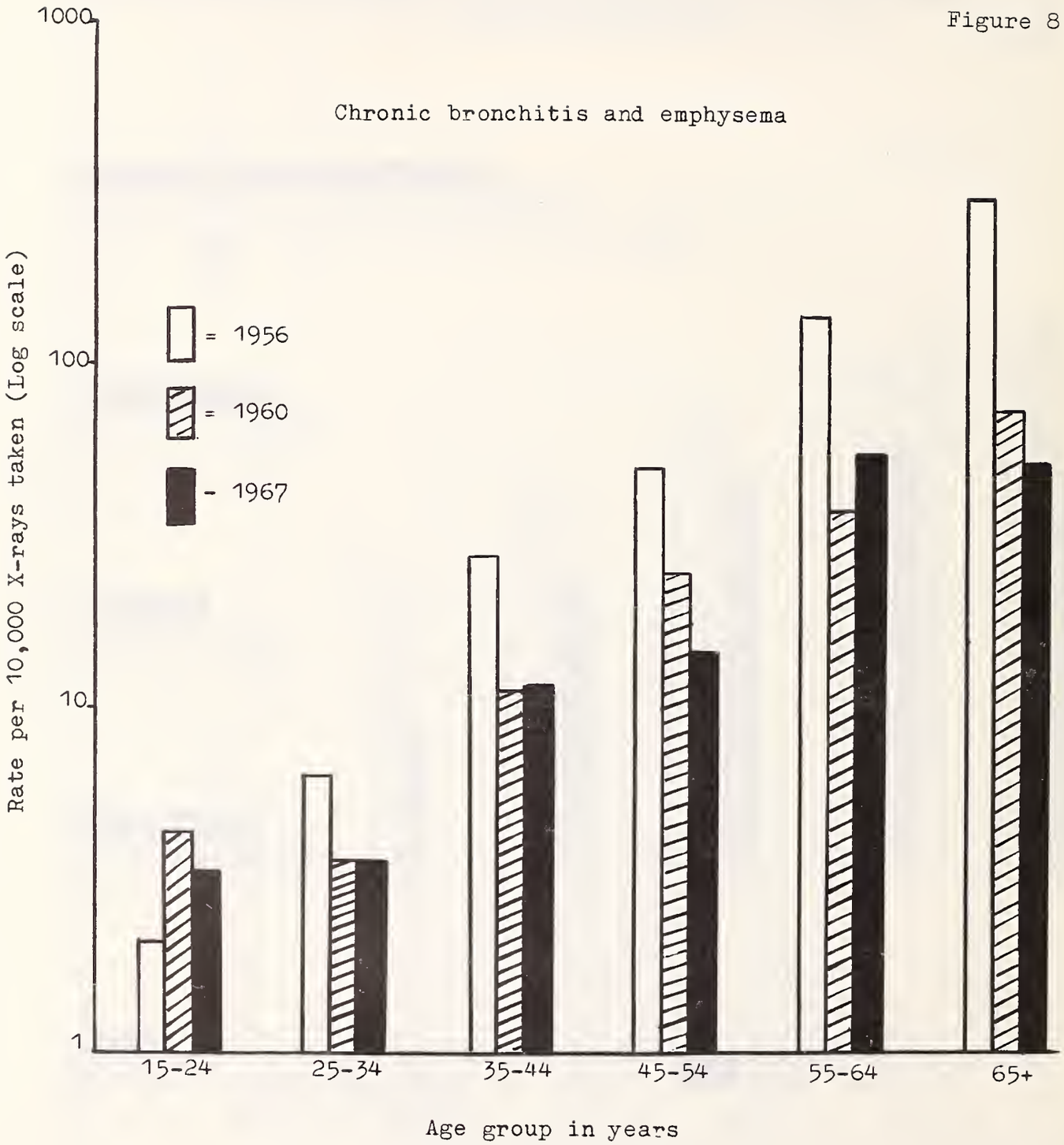
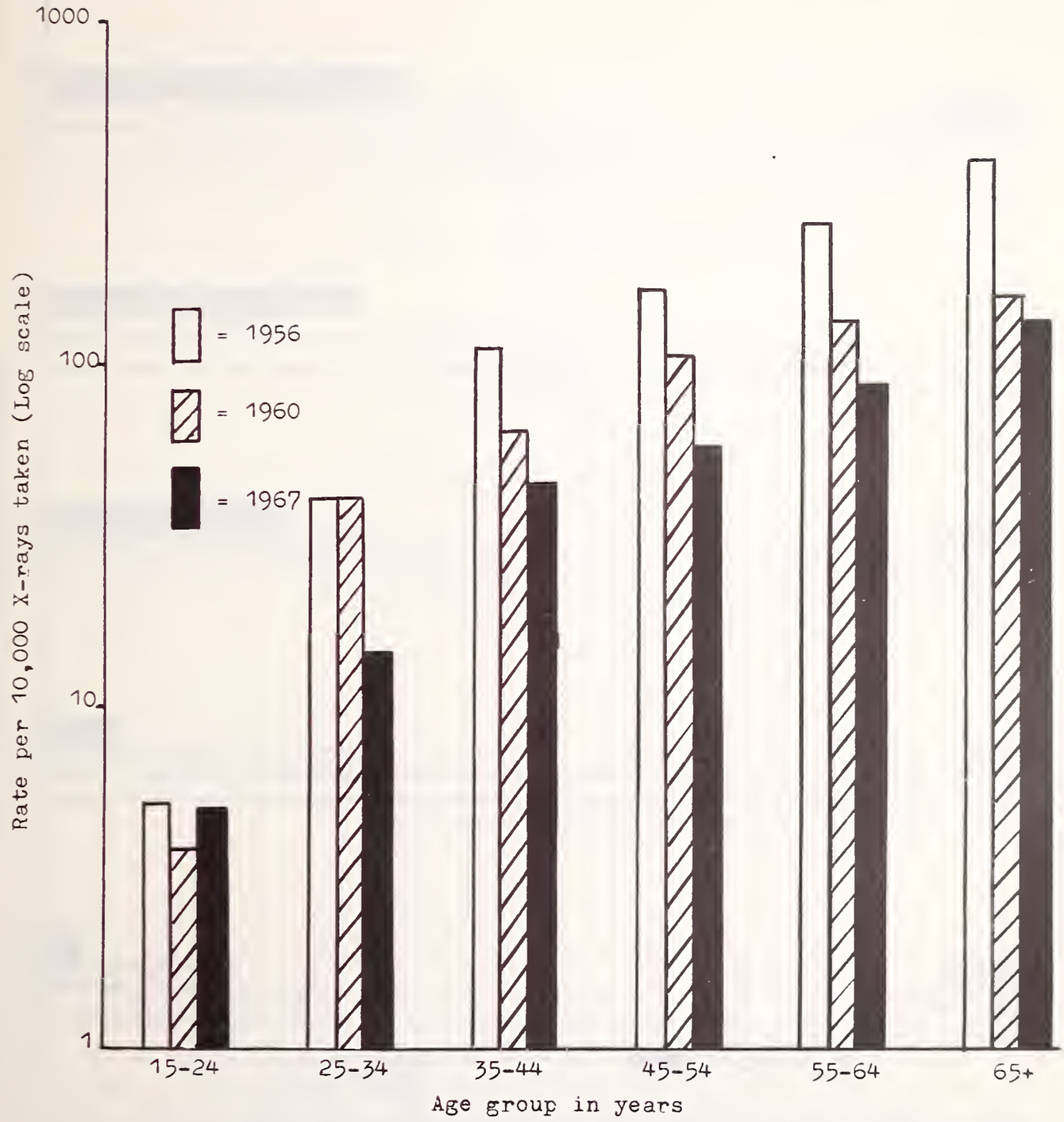

Chronic bronchitis and emphysema
1000
100
10
1
Rate per 10,000 X-rays taken (Log scale)
= 1956
= 1960
- 1967
15-24
25-34
35-44
45-54
55-64
65+
Age group in years

Figure 9

Arrested post-primary tuberculosis



Tuberculosis requiring supervision or treatment
1956, 1960 and 1967

Figure 10

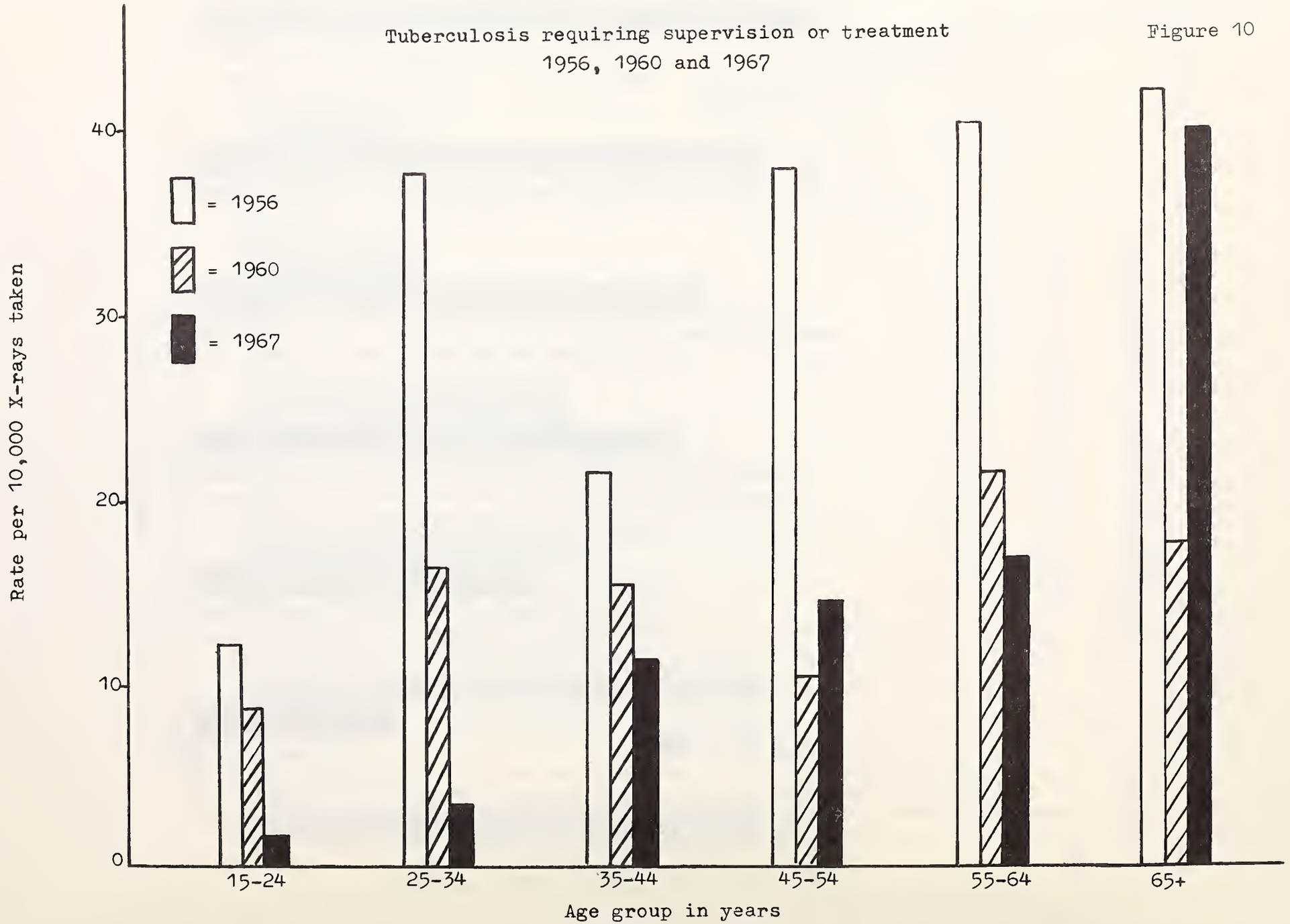
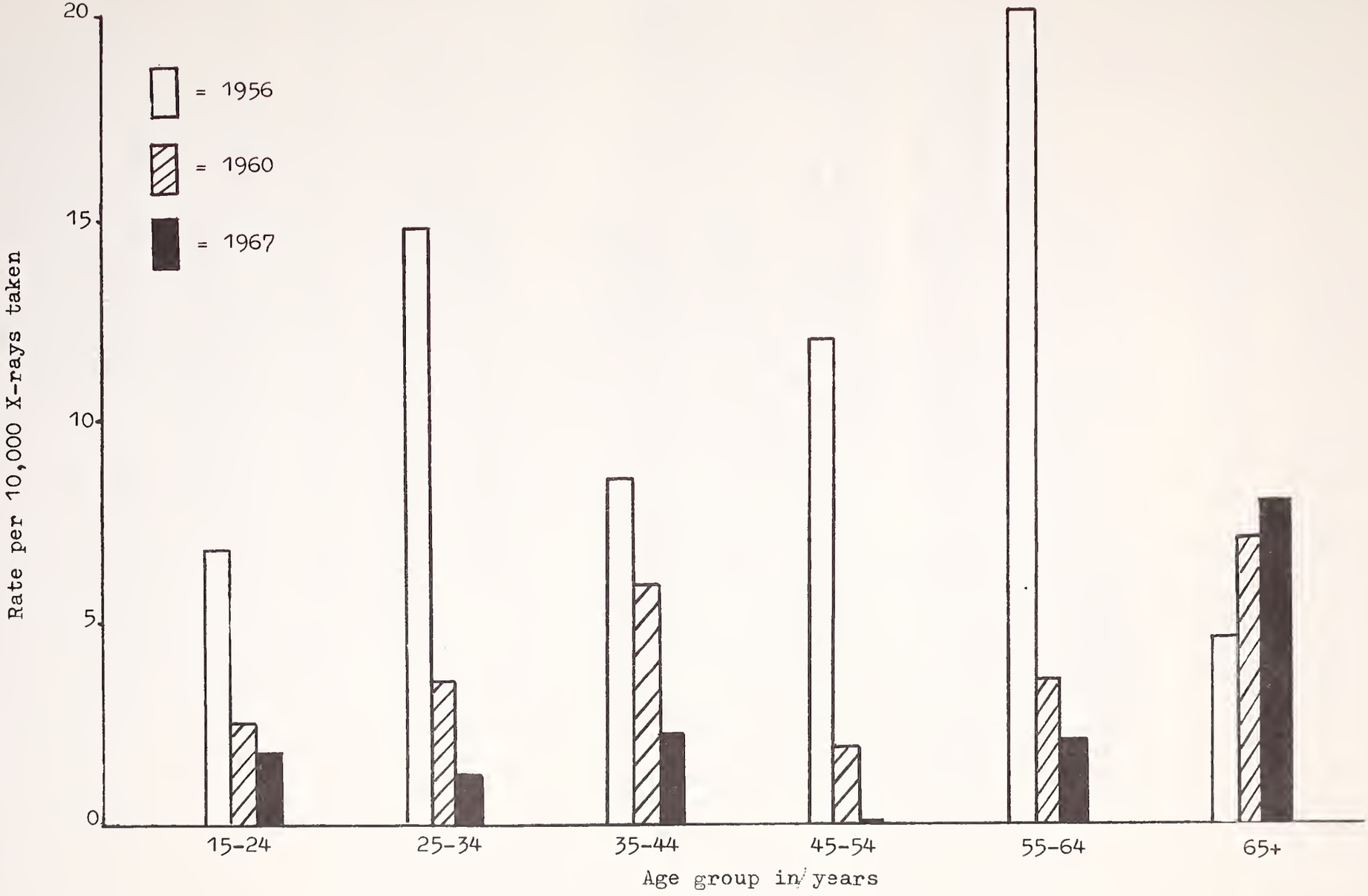


Figure 11

Active tuberculosis
1956, 1960 and 1967



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